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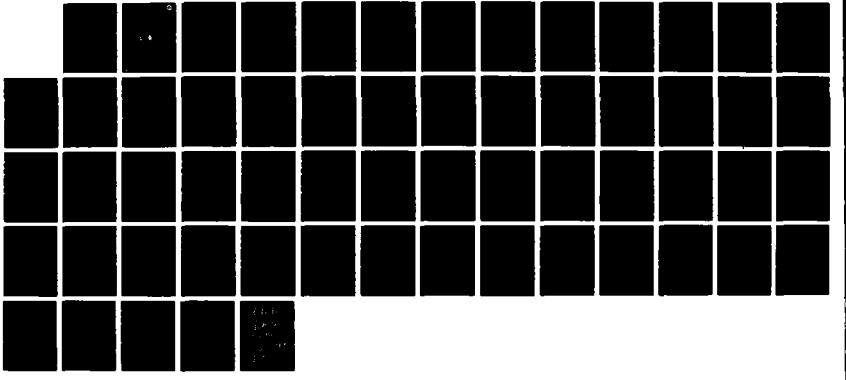

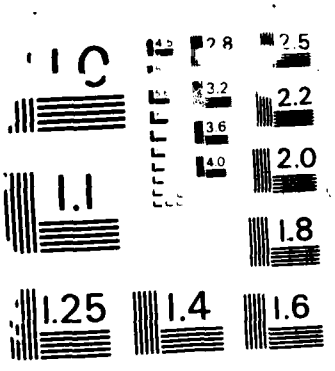

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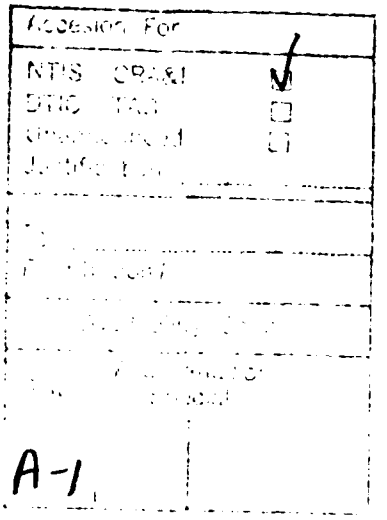

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Because the demand for scientific and technological talent exceeds the resources available within the Navy R&D centers and laboratories, the Commander of the Space and Naval Warfare Systems Command desires a system that managers can use to assist them in prioritizing and accepting R&D projects. With such a system, R&D managers would be able to evaluate the merit of potential projects, accept projects of highest priority, and defend their choices to outside reviewers. Such a system would also increase the congruence of R&D goals throughout the organization. The Laboratory Workload Prioritization and Acceptance System (LAWPAS) was proposed and evaluated at the Navy Personnel Research and Development Center. The results of this process are reported here. The use of LAWPAS as both an organizational assessment tool and as a decision aid for managers is discussed. Issues concerning the implementation and evaluation of LAWPAS in other R&D organizations are presented.

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FOREWORD

Because the demand for scientific and technological talent exceeds the resources available within the Navy R&D centers and laboratories, the Commander of the Space and Naval Warfare Systems Command (COMSPAWAR) desires a system managers can use to assist them in prioritizing and accepting R&D projects. The Laboratory Workload Prioritization and Acceptance System (LAWPAS) was proposed and evaluated at the Navy Personnel Research and Development Center (NAVPERSRANDCEN). The results of this process are reported here.

Appreciation is expressed to all senior and middle managers and principal investigators from NAVPERSRANDCEN who were involved in development of LAWPAS. We also express appreciation to Paul DeYoung for assistance with the data analysis.

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SUMMARY

Problem

Senior executives in the Space and Naval Warfare Systems Command (SPAWAR) expressed concern about the R&D project acceptance process in the Navy R&D centers and laboratories. A system to assist R&D managers in evaluating and prioritizing potential projects is needed. With such a system, R&D managers would be able to evaluate the merit of potential projects, accept projects of highest priority, and defend their choices to outside reviewers. Such a system would also increase the congruence of R&D goals throughout the organization.

Purposes

The purposes of this project were to: (1) develop a method for capturing the project acceptance policy of Navy R&D managers; (2) develop a "predicted merit equation" based on this policy using a sample of active R&D projects; (3) evaluate the usefulness of this equation for aiding project acceptance decisions and establishing a work acceptance policy.

Method

Ratings of a random sample of projects active in FY86 were collected from attribute raters (middle managers) and merit raters (senior managers). Middle managers used archival information and descriptions of projects provided by principal investigators to complete rating forms designed for the Laboratory Workload Prioritization and Acceptance System (LAWPAS). Senior managers used a one-page project description (Form 1498) to rank order projects by overall merit. Senior managers were also asked what criteria they believed were important for evaluating potential R&D projects at the Navy Personnel Research and Development Center (NAVPERSRANDCEN).

Results

Project information, attribute and merit raters' data, and multiple regression analyses are presented. The high reliability of the ratings allowed for the formation of regression equations with weighted dimensions for predicting potential merit of future projects.

Two equations were developed. The first equation was based on senior managers' ratings of overall merit. Important dimensions for predicting merit by this equation concerned whether the project focused on issues central to NAVPERSRANDCEN's mission, whether it had significant funding and was of funding type 6.3 (Advanced Development), and whether it focused on Navy issues. The second equation was based on middle managers' ratings of benefit/cost. Important dimensions in this equation are again concerned with whether the project's focus was central to NAVPERSRANDCEN's mission, whether the project's end-products were likely to "transition" to other R&D projects or the field, and whether the project was supported with 6.3 (Advanced Development) funding.

Conclusions and Recommendations

Dimensions important to prioritizing and accepting projects at NAVPERSRANDCEN were identified and combined into policy equations. These equations clarify what managers regard as important critieria for reviewing and accepting work at this organization.

The use of LAWPAS as both an organizational assessment tool and as a decision aid for managers is discussed. As a tool, the equations may be used proactively to predict the merit of potential R&D projects, and thereby assist in the project acceptance process. Issues concerning the implementation and evaluation of LAWPAS in other R&D organizations are also presented.

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INTRODUCTION

Problem

Senior executives in the Space and Naval Warfare Systems Command (SPAWAR) expressed concern about the project acceptance process in the Navy R&D centers and laboratories. A system to assist R&D managers in evaluating and prioritizing potential projects is needed. With such a system R&D managers would be able to predict the merit of potential projects, accept projects of highest priority, and defend their choices to outside reviewers. Such a system would also increase the congruence of R&D goals throughout the organization.

Purposes

The purposes of this project were to: (1) develop a method for capturing the project acceptance policy of Navy R&D managers; (2) develop a "predicted merit equation" based on this policy using a sample of active R&D projects; (3) evaluate the usefulness of this equation for aiding project acceptance decisions and establishing a work acceptance policy.

Background

Navy R&D centers and laboratories provide the Navy community with in-house R&D relevant to solving operational problems. The R&D centers and labs are a significant asset in implementing our national maritime strategy. They have their antecedents in the Navy's development and testing organizations established during the last half of the nineteenth and early part of the twentieth centuries. There now exist 12 Navy R&D centers and labs, each supporting a different area of research expertise. They "...are involved in all phases of research and technology and in all phases of the acquisition and maintenance process from concept formulation to in-service Fleet support" (Chief of Naval Material, 1980). They are devoted to providing the nation with "the best, most up-to-date, capable, and effective Fleet and Marine Corps forces which modern technology can provide for the resources available" (Department of the Navy, 1985).

In the past, the Navy R&D centers and labs have operated under normal constraints concerning the hiring of personnel, the contracting out of projects, and the distribution of funds from one fiscal year to the next. The hope has been that the constraints would be short-lived, allowing the center and labs to expand to meet the demands of the available workload. Unfortunately due to increasingly constrained federal fiscal resources, there is no reason to believe Navy R&D resources will expand. It is expected that the present constraints will increase, thus limiting the amount of work the centers and labs can assume.

These constraints have forced managers to reevaluate methods for achieving their organizational goals. One method for doing this is to accept only projects that are of highest priority and payoff to the organization. Thus the issue of specifying a project acceptance policy and process becomes critical.

Hundreds of project evaluation and selection models have been proposed and tested. Very few have been systematically implemented. Costello (1983) provides a review of many of these models, their methods and their shortcomings. Williams (1969) has categorized the models into three types based on their approach: (1) decision theory, (2) economic analysis, and (3) operational research. He concludes that the decision

theory approach is optimal, for it allows the use of numerous evaluation factors simultaneously.

The decision theory approach asks decision makers to identify critical dimensions, factors, or criteria for evaluating potential R&D projects. Many research efforts have been concerned with these dimensions (Costello, 1983). The Defense Science Board (Department of Defense, 1981) suggests three such criteria:

1. *Impact of opportunity.* Mission value, technology impact on mission, pervasiveness of impact.

2. *Technical risks.* Maturity of technology, innovation potential.

3. *System/operational concept risks.* Mission risk, political environment, level of operational support.

Doherty and Seymour (1983) suggest seven dimensions:

1. *Importance/necessity.* Value of the project to the Navy.

2. *Payoff.* Value of the product to the Navy weighted against the resources required for R&D and implementation.

3. *Timeliness.* Urgency to complete the project, political requirements, etc.

4. *Probability of success.* Probability that the effort would be successful (not including the probability that results could be implemented).

5. *Validity as R&D.* Scientific research and development.

6. *Link to other work.* Planned or approved work dependent upon completion of this project.

7. *Implementation.* The difficulty of implementing project end-products.

In the decision theory approach, dimensions are identified and weights attached to the dimensions to allow the scoring of R&D projects (Williams, 1969). These scores can then be ranked, and the highest scoring projects accepted based on available resources. Thus by identifying and appropriately weighting critical dimensions for evaluating R&D efforts, managers may be able to predict the merit of potential work and thereby decide whether or not to pursue the effort. This process aids decision making under conditions of uncertainty (Costello, 1983).

Besides the optimizing of resources, other benefits are likely to result from systematic R&D project evaluation and acceptance procedures. An explicit statement by upper-level managers of what makes projects valuable clarifies for others the R&D goals of the organization. The values, judgments, and standards of senior management can thus be applied to project evaluation and acceptance decisions without senior managers' involvement in every decision (European Industrial Research Management Association, 1978). Having a systematic process of project selection also simplifies explaining R&D project portfolios to outside reviewers. The process can encourage communication between different groups within the organization, and assist the organization in reaching consensus concerning its goals (Sounder, 1975).

Ideally, the development of a Laboratory Workload Prioritization and Acceptance System (LAWPAS) would result in the following:

1. Senior and middle managers' ideas regarding the relevant dimensions and weights for determining a project's merit would be captured in the policy equation.

2. Researchers could implement managers' policies in an economical and decentralized manner.

3. Once made explicit, the policy equation could be systematically evaluated and revised as necessary.

4. Projects could be evaluated using the policy equation at midyear, year-end, or milestone points.

5. If desired, the policy equations and minimum priority values or "cut scores" used to accept work could vary across different departments as well as across time as workload demands and resource availability fluctuate.

6. The whole process of work acceptance would be more systematic.

7. Increased discussion among organzational members concerning R&D goals and means to achieving these goals would result.

METHOD

The methodology for developing a Navy R&D center workload prioritization and acceptance system was tested at the Navy Personnel Research and Development Center (NAVPERSRANDCEN) during FY87. Center managers identified critical dimensions for the NAVPERSRANDCEN policy equation. The following eight steps summarize the procedure used in LAWPAS:

1. Identification of dimensions for evaluating R&D proposals.

The initial step was to establish a pool of dimensions for evaluating potential work at NAVPERSRANDCEN. Examples of dimensions critical in the R&D selection process were derived from past efforts devoted to characterizing R&D projects and products (Costello, 1983). In addition, senior managers were asked to provide dimensions they believed to be important in the R&D selection and evaluation process. The final pool of dimensions included those identified above plus the following unique items provided by NAVPERSRANDCEN senior managers:

a. Sponsorship. The organizational level or rank of the project sponsor and/or endorser.

b. Funding level. The amount and number of years of funding for the project.

c. Type of Funding. Research and development program element funds (6.1 - 6.5) versus reimbursable funds (program element code number 99000).

A project rating form having 29 items based upon the attributes of these dimensions was developed (Appendix A).

2. Selection of a sample of research projects.

A random sample of projects was used for data collection. The number of projects selected from each department was proportional to the number of projects funded in the department for FY86. Sixty-three projects were selected out of 178 R&D projects funded in FY86. Contracted projects and projects in support of R&D efforts were not chosen.

A principal investigator (PI) questionnaire (Appendix B) was sent out to all PIs for the selected projects requesting project information. This information was both factual (i.e., funding level, sponsors/endorser, start/end dates, etc.) and perceptual (impact of end-products, personnel affected by end-products, etc.).

3. Collection of project attributes ratings from middle managers.

Eighteen middle managers (GM/GS-13s and GM-14s) nominated by senior-level managers served as attribute raters. Senior managers were asked to select as raters managers with a broad range of experience and exposure to NAVPERSRANDCEN work. The number of attribute raters for each department was proportional to the number of people in each department.

Each attribute rater rated a group of 14 projects. The assignment of projects to groups, and groups to raters was random, except that in no case was an attribute rater asked to rate his/her own project. The grouping and assignment were done in a way that guaranteed that each project was rated four times, once each by four different raters. This procedure was chosen to minimize the workload required of the attribute raters, yet allow reliable estimates to be generated for each project by all raters.

A meeting was held with all of the attribute raters to describe the project and discuss how to complete the questionnaires. Attribute raters received the completed principal investigator questionnaires and Form 1498s (Appendix C) and other documentation [Technical Development Plans (TDPs) and Plan of Action and Milestones (POA&M)] for all the projects they were asked to rate. Attribute raters completed one attribute questionnaire for each of the 14 projects.

4. Collection of overall merit ratings from senior managers.

Senior managers (Commanding Officer, Technical Director, Department Directors, and other GM-15s) rated the selected projects on their overall merit, taking into consideration the costs in pursuing the project and the benefits that would ensue. This procedure was designed to establish the relative merit of the projects as seen by these senior managers.

A comparison procedure was used to obtain the overall merit ratings. Three projects were eliminated prior to this rating process because upon closer examination they were found to be contractual efforts that did not involve research and development. One-page descriptions (Form 1498) for the 60 projects were placed in a stack in front of the merit rater. The rater was asked to sort the projects in one of two ways: (1) The rater could use the first project as the anchor for the middle category, and place all projects into categories of lower, equivalent, or higher merit compared to this first project; or (2) the rater could separate the projects into three merit categories of low, medium, and high. The merit rater used whichever procedure was personally most meaningful.

Upon separating the 60 projects into three categories, each rater then separated the projects within each category again, using the same procedure. This process was continued until the merit rater felt the projects were adequately sorted and could no longer separate the projects into additional categories. Categories of projects were assigned ranks, with all the projects that were in the same category receiving the same number. Projects with the lowest merit received the rank of one.

After completing the sorting procedure, merit raters were asked what dimensions they felt were important in evaluating the merit of potential R&D projects at NAVPERSRANDCEN.

5. Estimation of attribute raters' ratings for all items for all projects.

The Ward-Jennings technique (1979) was used to estimate the attribute raters' ratings for those projects they did not rate. This procedure estimated the rating of all projects as if the raters had rated all projects on all 29 items. It provided a complete set of ratings for all projects by all raters, without having to require that each rater complete 63 questionnaires.

6. Creation of a policy equation.

The policy of senior managers in assigning overall merit to the projects was captured through the use of a least squares fit to a general linear model. Ratings on the dimensions made by the attribute raters along with objective information about the project were statistically regressed on the project's average overall merit rating to determine what dimensions were important in estimating merit, and the relative weights associated with each dimension. The solution to this equation made explicit which dimensions senior managers believe make a project successful at NAVPERSRANDCEN. These same procedures were used to capture the policy reflected in attribute raters' estimates of the overall benefit/cost ratio of the projects.

RESULTS

The distribution of projects and raters by department is presented below.

Table 1

DISTRIBUTION OF LAWPAS PROJECTS AND RATERS

Department	Merit Raters	Attribute Raters	Projects Selected
00/01	2	-	-
31	1	-	-
41	1	6	18
51	2	2	6
52	2	4	14
61	1	2	7
62	1	3	15
63	1	1	3
Total	11	18	63

The results will be presented in several sections: (1) project data, (2) attribute rater data, (3) merit rater data, and (4) building the policy equation.

Project Data

The principal investigator (PI) questionnaires (Appendix B) and Form 1498 (Appendix C) provided detailed information about the 63 projects selected. Projects with several different types of funding appeared in the random sample. Table 2 summarizes the projects by funding program element.

Table 2

FUNDING CATEGORIES FOR SELECTED PROJECTS

Funding Category		*Number of Projects*
61152N	In-house Independent Research	2
62744N	Marine Corps Air Ground Technology	2
62757N	Human Factors and Simulation Technology	3
62763N	Personnel and Training Technology	8
63502N	Advanced Surface Mine Countermeasures	1
63701N	Human Factors Engineering	2
63707N	Manpower and Personnel Systems	3
63720N	Education and Training	3
63732N	Advanced Manpower/Training	4
63733N	Simulation and Training Devices	1
63739N	Navy Logistics Productivity	1
64722A	Education and Training System Development - Army	1
99000N	Reimbursables	32
		63

Note: Only the primary funding category is reported.

As can be seen, the projects were evenly divided between R&D and reimbursable-funded projects. The mean FY86 funding level for the selected projects was $210,546; the median was $120,500, and standard deviation (SD) was $233,308.

A summary of the sponsors and endorsers of the projects is presented in Table 3.

Table 3

PROJECT SPONSORS/ENDORSERS AS REPORTED BY THE PRINCIPAL INVESTIGATORS

Sponsoring Command	*Number of Projects**
Secretary of the Navy/ Assistant Secretary of the Navy	6
Department of Defense	7
Office of the Chief of Naval Operations	21
Office of Naval Research/Office of Naval Technology/Chief of Naval Research	18
Space and Naval Warfare Systems Command/ Naval Sea Systems Command/Naval Air Systems Command/Naval Supply Systems Command/Navy Data Automation Command	18
Navy Military Personnel Command/ Navy Civilian Personnel Command	8
Chief of Naval Education and Training/ Chief of Naval Technical Training	7
Other	22

* *Does not sum to 63 because multiple responses were permitted.*

Project end-products usually were in the form of briefings, technical reports/notes, software, and conference papers. The mean number of months to deliver end-products was 18.33, with a median of 12.00, and standard deviation of 18.91. The settings in which end-products are/will be used are summarized in Table 4.

Attribute Rater Data

Each of the 18 attribute raters completed the attribute questionnaire (Appendix A) for a random set of 14 projects. The Ward-Jennings (1979) technique was used to estimate attribute raters' ratings for all projects not rated on the 29 items. The multiple regression coefficients from the analyses used to estimate the unobserved data elements indicate the degree of agreement between raters and the accuracy of the estimation of ratings not made. The multiple R ranged from .71 to .99; the mean R was .81. These values indicate a high degree of agreement among raters on the project attributes. The analysis procedure made it possible to correct for rater bias in the ratings given. With a corrected data set, the corrected average across raters for each of the 29 items for all the projects was computed.

Table 4

THE VARIOUS SETTINGS WHERE PROJECT END-PRODUCTS WILL BE USED

Setting	*Number of Projects**
Navy Shore Activities	28
Navy Operational Fleet	26
Navy R&D Centers/Laboratories	25
Other Military Activities	20
Government or DoD Headquarters	19
Universities	12
Private Sector Business	12
Navy Industrial Activities	8
Other Settings	9

* *Does not sum to 63 because multiple responses were permitted.*

Next, a principal components factor analysis of the 29 average corrected attributes was performed. A varimax rotation resulted in six dimensions, which are described in Table 5. Alpha coefficients were computed to estimate the reliability of the composite scores created by summing the items that clustered together in the factor analysis. The alpha coefficients ranged between .72 and .91. The means, standard deviations, and alpha coefficients are shown in Appendix D, Table D-1.

Merit Rater Data

The merit raters ranked the overall merit of the projects. Ties were permitted. Sixty of the projects received an overall merit rank score based on the merit rater sorting procedure. These scores were then standardized within raters to control for the number of categories into which the projects had been sorted, since this number varied somewhat by rater. The average merit rating for each project was then calculated across all 11 merit raters. Again, the degree of agreement between raters was analyzed. The alpha coefficient for interrater agreement was .86, showing a high degree of agreement between raters.

Table 5

QUESTIONNAIRE DIMENSIONS POTENTIALLY RELATED TO PROJECT MERIT

1. MISCNTRD *Centrality to NPRDC's Mission*

Questionnaire items[1]

A1a. To what extent are the issues addressed by this project important to NPRDC?
A2. To what extent do the issues addressed by this project correspond with NPRDC's formal mission?
B1a. To what extent does this project build upon NPRDC research and development?
B2a. To what extent does this project integrate with current NPRDC projects?
C1. To what extent will the end-product(s) from this project be useful to the R&D community?
C3. To what extent will the end-product(s) from this project reflect positively on NPRDC?
C5. To what extent will this work facilitate future opportunities for funding and/or applications?
C6d. To what extent is/will this project, compared to other NPRDC projects, be important and valuable to the Navy by expanding the technical base (developing new technology, procedures, etc)?

2. DODRD *Connectivity with DOD R&D*

Questionnaire items

B1c. To what extent does this project build upon other DoD research and development?
B2c. To what extent does this project integrate with current DoD R&D projects?

3. TRANSITN *Likelihood of Transitioning*

Questionnaire items

B3c. To what extent does the approach for this project seem to be feasible?
C4. What is the probability that end-products from this project could be implemented?

4. RISK *Project Risk*

Questionnaire items

A3. To what extent is NPRDC uniquely qualified to do this work? (reverse scored)
B1b. To what extent does this project build upon other Navy research and development?
B2b. To what extent does this project integrate with current R&D projects?
B4a. To what extent are there administrative risks associated with pursuing this project?
B4b. To what extent are there technical risks associated with pursuing this project?

5. NAVYOP *Usefulness to Operational Navy*

Questionnaire items

A1d. To what extent are the issues addressed by this project important to the operational Navy?
A2. To what extent do this issues addressed by this project correspond with NPRDC's formal mission?
C2. To what extent will the end-product(s) from this project be useful for Navy applications?
C6a. To what extent is/will this project, compared to other NPRDC projects, be important and valuable to the Navy by improving Navy effectiveness (e.g., meeting operational requirements, achieving stated goals, etc.)?
C6b. To what extent is/will this project, compared to other NPRDC projects, be important and valuable to the Navy by improving Navy efficiency (e.g., improving use of resources, reducing costs, etc.)?

6. SOUND *Scientific validity*

Questionnaire items

B3a. To what extend does the approach for this project seem to be methodologically sound?
B3b. To what extend does the approach for this project seem to be theoretically sound?

[1]The three major sections of the questionnaire are designated by capital letters (Appendix A). Section "A" refers to Attributes of the Problem Addressed, "B" to Attributes of the Project, and "C" to Attributes of End-products

Upon completing the sorting technique, raters were asked what dimensions they were using during the rating process. These comments were content-analyzed and collapsed into five dimensions; these are presented in Table 6. Three of the merit raters were asked to rate the projects again to get a measure of the intra-rater reliability. The average correlation between the original and second rating was .77, ranging from .71 to .85.

Table 6

MERIT RATERS' SELF-REPORT OF CRITICAL DIMENSIONS FOR EVALUATING POTENTIAL PROJECTS

Is it R&D?

Is there a well-articulated research goal?
Will this contribute to the technology base?
Is this project innovative, testing new ideas?
Does this build on prior work in the area?

Priority for the operational forces?

Does this address an identified Navy priority (i.e., ASW)?

What will the impact be?

Will this effort result in products with generalized application to the Navy?
Does this project have milestones with deliverable and usable products?
Are the end-products transitionable to other R&D or the fleet?
Will the end-products impact a broad range and number of people?
Is there an identifiable user?

Top-level support?

Does this effort have adequate funding?
Will this project have continued funding over time?
Is this project Congressionally-mandated?

Do we have the resources?

Is there a better agency to do the work?
What is the reputation of the principal investigator?
Is this "body shopping" that could easily be done by a contractor?

Building the Policy Equation

All the variables from both groups of raters and the principal investigator information were correlated to identify significant relationships between variables (Appendix E). A description of all the variables with significant correlations is presented in Table 7. The means, standard deviations, and alpha coefficients are found in Appendix D.

Table 7

VARIABLES INCLUDED IN THE REGRESSION ANALYSES

Merit Rater and Attribute Rater Variables

Variable	Label
MERIT	Average merit rating (CO, TD, and all GM-15's)
B_C	Overall benefit/cost from the attribute raters
MISCNTRD	Central to mission of the Center
NAVYOP	Usefulness to operational Navy
RISK	Degree of risk
DODRD	Connectivity with DoD R&D
TRANSITN	Likelihood of transitioning
SOUND	Scientific validity

Archival Information Variables

Variable	Label
ACTFUND	Actual funds received in FY86
LFUND	Log transform of the FY86 actual funding
TYPE1	6.1 Funding (binary)
TYPE2	6.2 Funding (binary)
TYPE3	6.3 Funding (binary)
TYPE4	6.4 Funding (binary)
TYPER	Reimbursable funds (binary)

Principal Investigator Questionnaire Variables

Variable	Label
INTEGRTN	Degree of integration with other projects
PERCENT	Percent of overall effort
YRS	Years until planned completion
INHOUSE	Percent in-house resources available at start-up
DIFFCLTY	Difficulty in getting resources
CONTRCT%	Percent contracted
INF/KNOW	Will the end-products change information/knowledge? (binary)
POLICY	Will the end-products change policy? (binary)
PROCEDR	Will the end-products change procedures/techniques? (binary)
SPONSORS	Number of sponsors
SETTINGS	Number of settings in which products will be used

Two stepwise regression analyses were conducted. All the variables in Table 7 were entered into the regression analysis to predict two criteria. The first analysis regressed the variables on the average merit rating calculated from the merit raters. The results are presented in Table D-2, forming the following equation:

PMERIT = (.690 * MISCNTRD) + (.321 * LFUND) + (-.241 * DODRD)
+ (-.212 * POLICY) + (.172 * TYPE3)

The second analysis regressed the variables on the overall benefit/cost rating produced from the attribute raters. Table D-3 presents the results of this analysis and the following equation:

PB/C = (.773 * MISCNTRD) + (.378 * TRANSITN) + (.145 * TYPE3) + (-.154 * RISK)
+ (-.143 * INHOUSE)

The weights reported here in the equations are the standardized regression weights (Beta). The correlation between actual merit and actual benefit/cost ratings and predicted merit and predicted benefit/cost ratings is summarized in Table 8.

Table 8

CORRELATIONS BETWEEN MERIT CRITERIA
AND PREDICTED CRITERIA

	MERIT	B/C	B/CMRT	PMERIT	PB/C
B/C	.550	1.000			
B/CMRT	.880	.880	1.000		
PMERIT	.830	.702	.870	1.000	
PB/C	.638	.921	.886	.794	1.000
PB/CPMRT	.775	.857	.927	.947	.947

Labels

MERIT	Average merit rating
B/C	Overall benefit/cost rating from attribute raters
B/CMRT	Average of MERIT and B/C
PMERIT	Predicted MERIT
PB/C	Predicted B/C
PB/CPMRT	Average of predicted B/C and predicted MERIT

CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations are concerned with four areas based on the results described above: (1) interpretation of policy equations, (2) benefits of LAWPAS, (3) evaluation of LAWPAS, and (4) future applications.

Interpretation of Policy Equations

Several conclusions can be drawn from a review of the dimensions found in the policy equations. The equation based on the merit raters emphasizes several dimensions. Projects focusing on issues central to NAVPERSRANDCEN'S mission (MISCNTRD) have higher worth and merit. Also 6.3 Advanced Development-funded projects (TYPE3) with significant funding (LFUND) were rated higher in terms of merit. Projects addressing Navy R&D concerns were rated higher than those built upon or integrated with DoD projects (negative weight on variable DODRD). Lastly, projects thought to influence policy (negative weight on variable POLICY) were not valued as much as those addressing information/knowledge (INF/KNOW) and procedures/techniques (PROCEDR).

The equation based on the attribute raters is similar in several respects but somewhat different. Middle managers/researchers agreed with senior managers that projects addressing the center's mission were more highly valued (MISCNTRD). They also valued projects that were likely to transition (TRANSITN) to other R&D projects or into the field. Attribute raters also rated highly those projects with 6.3 (Advanced Development) funding (TYPE3) and projects with lower risk (negative weight on variable RISK). Also rated highly were those projects perceived to be of sufficient value to warrant redirection of in-house resources to make the project possible (negative weight on the variable INHOUSE).

A few rather unexpected relationships appeared in these equations. Several managers expressed surprise at the fact that DoD R&D was not highly valued, as demonstrated by the negative weight attached to that dimension. At face value this appears to be contradictory to the mission of a Navy R&D center that is part of DoD. But it was found that those projects focusing on Navy issues (NAVYOP) were of very high merit. Thus it seems that projects focusing on issues useful to the operational Navy are seen as having greater merit than those focusing on issues important to other services. The negative relationship with the policy variable also suggests an inverse effect, that those projects impacting information/knowledge and procedure/techniques are seen as more valuable.

The negative relationship between the risk variable and overall merit should not be taken at face value, for comments from attribute raters emphasized that they valued risk when conducting R&D. It is realistic to say that projects with high risk have unknown payoffs, and usually have low expected benefit/cost ratings. Since this equation was calculated in terms of overall benefit/cost, it is not surprising that the risk variable was rated in this fashion.

These examples demonstrate an important point concerning LAWPAS. The policy captured by these equations is the policy being used by managers to evaluate existing or past work. This captured policy may not represent the preferred policy. What has been reported in the results are those dimensions that managers currently value in judging and accepting work. It is possible that the organization would like to shape those values differently, and consciously emphasize dimensions that may not currently be highly valued. Thus the policy equation may in the future be altered to reflect those dimensions the organization would like to emphasize in its work acceptance policy. This

equation could be a combination of the dimensions both middle and senior managers value. This would allow for the clear and concise specification of the organization's R&D goals.

Benefits of LAWPAS

LAWPAS is useful in many respects. The process of rating projects and capturing policy provides insight to the organization. It clarifies for managers what dimensions they perceive to be valuable in accomplishing their organization's mission. This process also clarifies the extent to which the policy viewpoints of senior and middle managers are congruent.

The policy equation may also be used by managers in a proactive way to design projects emphasizing those dimensions valued by the organization. Currently, projects lasting longer periods of time with larger amounts of funding and emphasizing Navy R&D concerns are more highly valued than quick turnaround projects with low levels of funding and focusing on services or groups other than Navy. Revising a project to fit this profile should increase its merit score and also better reflect the mission of the organization.

Managers expressed concern that implementing the policy equation would infringe on their decision-making authority in terms of work acceptance. It needs to be clearly understood that the policy equation is based upon data generated by the managers. The essence of their policy viewpoints is captured with the equation. The predicted merit scores are just another source of information when deciding whether to accept or reject a project. This information may be particularly useful for projects that are difficult to decide upon in terms of acceptance. Managers will need to continue to give consideration to a variety of information in the decision-making process, such as the priority of the requirement or whether the request comes from a long-term sponsor. The results of the policy equation will not replace the manager in the work acceptance decision but will serve as a tool to assist the manager in making the decisions required.

In the past, simple work acceptance algorithms have proven much more effective than complex, sophisticated algorithms (Liberatore & Titus, 1983). Thus, in developing a decision aid, a simple algorithm that satisfactorily deals with the work acceptance problem should be used to estimate the merit of proposed R&D projects. The LAWPAS equation seems to meet that criterion. By using the LAWPAS equation to predict the merit of potential projects, the manager has an aid to assist in the project selection and evaluation process. If the decision is not to accept the project at this time because its predicted merit is low, the manager's choices are to (a) defer the decision and postpone the effort, (b) renegotiate the terms of the project so that it is of higher merit, or (c) reject it outright.

Evaluation of LAWPAS

There are three areas where LAWPAS needs to be evaluated as it is implemented within an organization. The high reliability achieved from 18 attribute raters and 11 merit raters may not be achieved when using a somewhat smaller number of raters.[1]

[1] In the process of collecting the ratings from both attribute and merit raters, many people expressed skepticism that agreement of ratings would be found. Several attibute raters felt that they could not rate the projects on the dimensions, and that the data resulting from this would be random and incomprehensible. Interestingly enough, much more agreement was found between the raters than even the authors expected. Attribute raters agreed on ratings of project dimensions and on the overall project benefit/cost to a high degree. Merit raters also agreed highly on the overall merit ratings of projects, and these two groups valued many similar dimensions associated with the projects. Due to this high level of agreement among the raters, confidence in the results is high.

The reliability of a smaller group of raters can be estimated, but the reliability achieved with a smaller set needs to tracked.

Second, the ratings were gathered on projects already active in FY86. Due to intense review of all projects active during that particular fiscal year because of many external review committees visiting NAVPERSRANDCEN, many raters may have had more information available to them than would be typical. In addition, ratings of historical data may be much more reliable than ratings of data gathered for proposed projects. Certainly there is more information available on an active project and greater familiarity among the raters with it than with one that is proposed. Again, the reliability of the process must be tested using projects that have not yet been initiated.

Third, the process at NAVPERSRANDCEN included only those projects that were already accepted and initiated; it did not include those projects that were proposed at the start of the fiscal year but not accepted or funded. The process needs to be tested at the beginning of a fiscal year and include all proposed projects. Then the ability of the equation to accurately predict merit under these circumstances can be assessed.

Future Applications

This procedure has many potential applications both within NAVPERS-RANDCEN and within other R&D organizations. The data collection forms were revised to include only that information found to be significant or thought to be important in the future for NAVPERSRANDCEN (Appendices F and G). The proposed rating form would need to be revised for each organization to include dimensions senior managers believe to be relevant and important for their specific situation. Instructions have been included on how to calculate predicted merit for proposed projects (Appendix H).

There are several issues to consider when implementing LAWPAS. First, managers need to determine which projects should be assessed using the policy equation. Should all projects be evaluated or just reimbursable projects so that program element tasks that have been planned in the funding cycle are exempt from the procedure?

Second, there is the issue of when to apply the equation to projects. If the equation will be used to assess the merit of possible program element tasks, should these be evaluated prior to submitting requests for funds? What about applying the equation to ongoing projects to help determine if resources are being used in an optimal manner?

A third issue in implementing LAWPAS concerns gaining an understanding of the meaning of the merit scores. When used over time, a distribution of the predicted merit scores can be constructed. It is then possible to gain a clearer understanding of the meaning of the predicted scores. It would be possible then to define ranges or cut scores based on resources available. These could be regularly revised to allow for changes in the distribution of the predicted scores along with changes in the operating environment of the organization.

It is important to note that the results from LAWPAS capture policy viewpoints at a particular point in time. For it to be an effective management tool, the process should be repeated, possibly every year, so as to accurately reflect changes in priorities and policy viewpoints.

There are several considerations when transitioning LAWPAS to new organizations. It would be desirable to be able to make a quick assessment of an organization to determine if acceptable agreement can be found among managers in their

ratings of projects. If a high enough level of reliability in ratings is not achieved, there are several possible explanations. The instruments used to gather the ratings may not be effective for this particular organization. Or it may be that there is little, if any, agreement on the values assigned to the dimensions of the rated projects. If such a situation exists, it may not be worthwhile to continue with the LAWPAS process unless the organization wishes to do so for self-assessment purposes, with no expectation of a reliable policy equation resulting as an end-product.

Describing LAWPAS to managers who lack an extensive understanding of statistics and reliability measures may also be a problem when transitioning LAWPAS to other R&D organizations. What is a meaningful method for describing the results of this process to managers and engineers? How else may these data be conveyed so as to make sense?

LAWPAS proved to be successful at NAVPERSRANDCEN. Managers felt that the results were useful in clarifying important dimensions for reviewing potential R&D projects. The level of agreement achieved and defined through the process may lead to a much more systematic evaluation and acceptance of work. It was useful for senior managers to realize that they agree with each other in their policy viewpoints more than they disagree. LAWPAS also served as a communication tool between senior and middle managers, highlighting similarities and differences in their viewpoints. It remains to be seen whether NAVPERSRANDCEN will fully implement LAWPAS over time, but as an organizational assessment tool, it has served its purpose well.

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APPENDIX A

ATTRIBUTE RATER QUESTIONNAIRE

Project Number _____ 4/20/87

Rater _____

Please complete the following items for the above identified project. Information detailing the project is attached for your reference. Reference to the Navy includes both Navy and Marine Corps. If you are unable give an exact response, then give your best estimate.

A. Attributes of the Problem Addressed

1. To what extent are the issues addressed by this project *important* to:

a) NPRDC?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

b) the Navy R&D community?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

c) Government funding organizations (e.g., SYSCOMS, Congress)?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

d) The operational Navy?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

e) The private sector?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

2. To what extent do the issues addressed by this project correspond with **NPRDC**'s formal mission?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

3. To what extent is **NPRDC** uniquely qualified to do this work?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

4. To what extent are <u>other</u> Navy R&D centers/laboratories better able to handle this project?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

B. Attributes of the Project

1. To what extent does this project build upon:

a) NPRDC research and development?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

b) other Navy research and development?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

c) other DoD research and development?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

2. To what extent does this project integrate with current:

a) NPRDC projects?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

b) other Navy R&D projects?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

c) other DoD R&D projects?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

3. To what extent does the approach for this project seem to be:

a) methodologically sound?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

b) theoretically sound?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

c) feasible?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

4. To what extent are there:

a) administrative risks (delays, cuts in funding, etc.) associated with pursuing this project?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

b) technical risks associated with pursuing this project?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

C. Attributes of End-product(s)

1. To what extent will the end-product(s) from this project be useful to the R&D community?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

2. To what extent will the end-product(s) from this project be useful for Navy applications?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

3. To what extent will the end-product(s) from this project reflect positively on **NPRDC**?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

4. What is the probability that end-products from this project could be implemented?

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

5. To what extent will this work facilitate future opportunities for funding and/or applications?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

6. Please indicate to what extent this project, compared to other NPRDC projects, is or will be <u>important</u> and <u>valuable</u> to the Navy by:

a) improving Navy effectiveness (e.g., meeting operational requirements, achieving stated goals)?

0	1	2	3	4	5	6	7	8	9	10
Value less than 90% of projects				Value equal to middle 20% of projects						Value greater than 90% of projects

b) improving Navy efficiency (e.g., improving use of resources, reducing costs)?

0	1	2	3	4	5	6	7	8	9	10
Value less than 90% of projects				Value equal to middle 20% of projects						Value greater than 90% of projects

c) improving Navy personnel quality of life (e.g., improve morale, increase job satisfaction)?

0	1	2	3	4	5	6	7	8	9	10
Value less than 90% of projects				Value equal to middle 20% of projects						Value greater than 90% of projects

d) expanding the technical base (e.g., developing new technology, procedures)?

0	1	2	3	4	5	6	7	8	9	10
Value less than 90% of projects rojects				Value equal to middle 20% of projects						Value greater than 90% of p

7. Overall, to what extent do you perceive the benefits of undertaking this project outweighing the costs?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

APPENDIX B

PRINCIPAL INVESTIGATOR QUESTIONNAIRE

PRINCIPAL INVESTIGATOR QUESTIONNAIRE

The information you provide here is part of the information that will used by a set of judges to rate the attributes of selected projects. Please complete the following items as accurately and completely as possible.

Project/Work Unit_____

_____**(see attached 1498)**

PI_____

1. Please check the organizations funding and/or endorsing this project. For each organization checked, indicate the specific code providing funding and/or endorsing the project.

____SECNAV_____	____ONT_____
____ASN_____	____ONR_____
____DoD_____	____NAVSEA_____
____OPNAV_____	____NAVAIR_____
____SPAWAR_____	____NAVSUP_____
____NMPC_____	____NAVDAC_____
____NCPC_____	____NAVFAC_____
____NRC_____	____Other (specify)_____
____CNR_____	____Other (specify)_____
____CNET_____	____Other (specify)_____
____CNTT_____	

2. Please indicate the rank or grade of the highest official endorsing this project.

____Political Appointee ____Elected Official

____O-10 ____O-9 ____O-8 ____O-7 ____O-6 ____O-5

____SES ____GM/GS-15 ____GM/GS-14 ____GM/GS-13

3. What funding level ($K) was originally planned for this project over its entire duration?

_____

4. Was/is this project part of an integrated set of projects?_____

If so, what percent of the total effort does it represent?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. To what extent does this work support elements of your department's Work Breakdown Structure?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

6. a) What was/is the **planned** start date of this project?_____

b) What was the **actual** start date?

c) What was/is the **planned** end date of this project?_____

d) If completed, what was the **actual** end date?

7. What percent of the in-house resources (e.g., personnel, equipment, facilities) required to perform this project were available when the project was initiated?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. If less than 100%, how difficult was it to obtain the remaining resources?

0	1	2	3	4	5	6	7	8	9	10
Not at all difficult					Somewhat difficult					Extremely difficult

9. What percent of the total funding for this project was contracted?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

10. Please indicate the number of end-products this project has or is planned to produce over its entire duration for each category:

_____Software
_____Hardware
_____Operating/administrative procedures
_____System/equipment design specifications
_____NPRDC technical note/report
_____Journal article
_____Briefing
_____Convention paper
_____Other (specify)_____

11. Please indicate what did/will change as a result of this project's end-products.

_____Information/knowledge
_____Policy
_____Procedures/Techniques

12. Please check the setting(s) in which end-products of this project are/will be used.

_____The operational fleet

_____Navy shore activities

_____Navy industrial activities

_____Navy R&D centers and laboratories

_____Other military activities

_____Government or DoD headquarters (policy makers)

_____Universities

_____Private sector businesses

_____Other (specify)_____

13. To what extent did/will each of the following groups be directly affected by this project's end-products:

a) Military recruits

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

b) Military officers

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

c) Enlisted personnel

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

d) Military dependents

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

e) Government civilian employees

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

f) Government contractors

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

g) Other private sector personnel

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

14. How many months did/will elapse from the initiation of this project until end-products were will be delivered to a customer? _____ months

15. To what extent did/will existing conditions have to be altered to implement end-products from this project?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

APPENDIX C

SAMPLE OF FORM 1498

RESEARCH AND TECHNOLOGY WORK UNIT SUMMARY				1 AGENCY ACCESSION DN297508	2 DATE OF SUMMARY 15 OCT 86	REPORT CONTROL SYMBOL
3 DATE PREV SUMMARY 15 FEB 86	4 KIND OF SUMMARY D CHANGE	5 SUMMARY SCTY U	6 WORK SECURITY U	7 REGRADING	8 DISP'N INSTR'N CX	9 LEVEL OF SUM A WORK UNIT

10 NO CODES	PROGRAM ELEMENT	PROJECT NUMBER	TASK AREA NUMBER	WORK UNIT NUMBER
a PRIMARY	62763N	F63521	RF63521804	521804-031-03.CE
b CONTRIBUTING				
c CONTRIBUTING	83	PERSONNEL AND TRAINING		

11 TITLE (Precede with Security Classification Code) (U) PERSONNEL ASSIGNMENT OPTIMIZATION

12 SUBJECT AREAS 0501

13 START DATE	14 ESTIMATED COMPLETION DATE	15 FUNDING ORGANIZATION	16 PERFORMANCE METHOD
01 OCT 80	30 SEP 87	DN	C IN-HOUSE

17 CONTRACT/GRANT

a DATE EFFECTIVE	EXPIRATION
b CONTRACT/GRANT NUMBER	
c TYPE	d AMOUNT
e KIND OF AWARD	f CUM TOTAL

18 RESOURCES ESTIMATE

FISCAL YEARS	a PROFESSIONAL WORKYEARS	b FUNDS (In thousands)
86	1.5	405.0
87	1.5	321.0

19 RESPONSIBLE DOD ORGANIZATION 390772 0640	20 PERFORMING ORGANIZATION 390772 0640
a NAME NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER	a NAME NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER
b ADDRESS (include zip code) SAN DIEGO, CA 92152-6800	b ADDRESS SAN DIEGO, CA 92152-6800
c NAME OF RESPONSIBLE INDIVIDUAL BLANCO, T.A. 61	c NAME OF PRINCIPAL INVESTIGATOR LIANG, T. 61
d TELEPHONE NUMBER (include area code) 619-225-7642	d TELEPHONE NUMBER (include area code) 619-225-2371
21 GENERAL USE H MILITARY/CIVILIAN APPLICATION	e NAME OF ASSOCIATE INVESTIGATOR (if available) KRASS, I.
	g NAME OF ASSOCIATE INVESTIGATOR (if available)

22 KEYWORDS (Precede EACH with Security Classification Code) (U) MANPOWER MANAGEMENT; (U) PE 62763N; (U) CAREER PLANNING; (U) DISTRIBUTION POLICY

23 TECHNICAL OBJECTIVE 24 APPROACH 25 PROGRESS (Precede text of each with Security Classification Code)

23. OBJECTIVE: (U) NAVY PERSONNEL ASSIGNMENT IS A LARGE, COMPLEX OPERATION. OVER 500,000 ACTIVE ENLISTED PERSONNEL ARE ASSIGNED TO SOME 5,000 DIFFERENT ACTIVITIES OR UNITS IN ABOUT 300 DISTINCT OCCUPATIONAL SPECIALTIES AND AT NINE DIFFERENT SKILL LEVELS. THE OBJECTIVE OF THIS EFFORT IS TO INVESTIGATE AND DEVELOP METHODOLOGIES TO SOLVE COMPLEX, LARGE-SCALE, MULTIPLE-CRITERIA OPTIMIZATION PROBLEMS ASSOCIATED WITH NAVY PERSONNEL ASSIGNMENT. FORMER WORK UNIT NUMBER 521-804-031. FORMER TITLE CAREER MANAGEMENT PLANNING (CAMP). INCLUDES WORK UNIT WR-22025.

24. APPROACH: (U) THE APPROACH IS TO (1) INVESTIGATE AND DEVELOP NEW COMPUTATIONAL NETWORK CODES CAPABLE OF HANDLING A LARGE VARIETY OF OBJECTIVES AND CONSTRAINTS FOR THE NAVY'S ASSIGNMENT PROBLEM, (2) EXPLORE STRUCTURED MODELING AND AGGREGATION THEORY FOR INTERFACING THE LINKS IN POLICY SETTING AT THE STRATEGIC LEVEL AND IMPLEMENTATION AT THE OPERATIONAL LEVEL, AND (3) EXAMINE THE POTENTIAL USE OF ARTIFICIAL INTELLIGENCE/EXPERT SYSTEMS TECHNOLOGY IN ASSIGNMENT SYSTEMS.

25. PROGRESS: (U) (OCT 85 - MAR 86): A NEW COMPUTATIONAL NETWORK CODE WAS DEVELOPED THAT CAN SOLVE AN ASSIGNMENT PROBLEM WITH 19 ENROUTE TRAINING CAPACITY CONSTRAINTS THAT ARE UNIFORM (I.E., THE QUOTAS ARE ALL THE SAME). THIS DEVELOPMENT IS AN ENCOURAGING STEP TOWARD DEVELOPING ALGORITHMS TO SOLVE ASSIGNMENT PROBLEMS FOR ENLISTED RATINGS WITH MULTIPLE NAVY ENLISTED CLASSIFICATIONS AND CLASS 'C' SCHOOLS THAT MUST UNDERGO EXTENSIVE ENROUTE TRAINING.

DD FORM 1498 NPRDC/OP 3500 1 (Rev 2 85 EDITION OF MAR 68 S OBSOLETE

APPENDIX D

VARIABLES INCLUDED IN THE REGRESSION ANALYSES

Table D-1

MEANS, STANDARD DEVIATIONS, AND RELIABILITY FOR VARIABLES

(Cases = 60)

VARIABLE	MEAN	STD DEV	RELIABILITY
MERIT	6.000	1.297	.86
B/C	6.226	1.445	.92
MISCNTRD	5.682	1.421	.91
NAVYOP	6.005	1.482	.89
RISK	3.929	1.944	.84
DODRD	3.634	1.597	.88
TRANSITN	6.898	1.210	.77
SOUND	6.787	1.294	.72
ACTFUND	202445.000	522.554	
LFUND	5.086	.476	
TYPE1	.033	.181	
TYPE2	.200	.403	
TYPE3	.233	.427	
TYPE4	.017	.129	
TYPER	.483	.504	
INTEGRTN	.533	.503	
PERCENT	64.600	36.392	
YRS	2.817	1.935	
INHOUSE	74.500	28.711	
DIFFCLTY	2.867	3.100	
CONTRCT%	23.383	21.381	
INF/KNOW	.833	.376	
POLICY	.383	.490	
PROCEDR	.850	.360	
SPONSORS	1.800	1.162	
SETTINGS	2.433	1.671	

Table D-2

MULTIPLE REGRESSION ON MERIT RATERS' AVERAGE OVERALL MERIT RATINGS (MERIT)

DEPENDENT VARIABLE MERIT

MULTIPLE R	.83005
R SQUARE	.68898
ADJUSTED R SQUARE	.66018
STANDARD ERROR	.75598

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	5	68.36427	13.67285
RESIDUAL	54	30.86113	.57150

F = 23.92441 SIGNIF F = .0000

---------- VARIABLES IN THE EQUATION ----------

VARIABLE	B	SE B	BETA	T	SIG T
MISCNTRD	.630101	.080469	.690408	7.830	.0000
LFUND	.872882	.247518	.320504	3.527	.0009
DODRD	-.196120	.070371	-.241561	-2.787	.0073
POLICY	-.559802	.211184	-.211647	-2.651	.0105
TYPE3	.524012	.250030	.172344	2.096	.0408
(CONSTANT)	-1.214168	1.122480		-1.082	.2842

Table D-3

MULTIPLE REGRESSION ON ATTRIBUTE RATERS'
AVERAGE OVERALL BENEFIT/COST RATINGS (B/C)

DEPENDENT VARIABLE B/C

MULTIPLE R	.92119
R SQUARE	.84858
ADJUSTED R SQUARE	.83456
STANDARD ERROR	.58776

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	5	104.52705	20.90541
RESIDUAL	54	18.65119	.34539

F = 60.52654 SIGNIF F = .0000

---------- VARIABLES IN THE EQUATION ----------

VARIABLE	B	SE B	BETA	T	SIG T
MISCNTRD	.785814	.055213	.772787	14.232	.0000
TRANSITN	.451882	.066938	.378442	6.751	.0000
TYPE3	.500490	.185194	.147739	2.703	.0092
RISK	-.114400	.042347	-.153950	-2.702	.0092
INHOUSE	-.007193	.002768	-.142938	-2.598	.0120
(CONSTANT)	-.487197	.662315		-.736	.4652

APPENDIX E

CORRELATION MATRIX

CORRELATION MATRIX

	MERIT	B/C	MISCNTRD	NAVYOP	RISK	DODRD	TRANSITN
MERIT	1.000	.550	.718	.553	.218	.165	.001
B/C	.550	1.000	.758	.721	-.133	.259	.444
MISCNTRD	.718	.758	1.000	.626	.166	.433	.004
NAVYOP	.553	.721	.626	1.000	-.096	.308	.345
RISK	.218	-.133	.166	-.096	1.000	.152	-.321
DODRD	.165	.259	.433	.308	.152	1.000	-.177
TRANSITN	.001	.444	.004	.345	-.321	-.177	1.000
SOUND	.242	.591	.399	.433	-.335	.106	.406
TYPE1	.068	.244	.203	.070	-.152	.081	.022
TYPE2	.212	.048	.245	.090	.073	.249	-.179
TYPE3	.300	.235	.067	.220	.070	-.044	.045
TYPE4	.098	-.006	.078	-.009	.030	.092	-.034
TYPER	-.474	-.323	-.346	-.283	-.073	-.216	.108
ACTFUND	.464	.176	.327	.290	.223	.241	.003
LFUND	.528	.231	.396	.329	.213	.305	-.027
INTEGRTN	.091	.014	.258	-.115	.298	.334	-.320
PERCENT	-.062	.008	-.284	.069	-.301	-.350	.374
YRS	.477	.173	.307	.291	.228	.130	-.161
INHOUSE	-.156	-.304	-.164	-.054	-.018	.076	-.107
DIFFCLTY	.280	.291	.195	.024	.074	.021	.047
CONTRCT%	.170	.070	.169	.170	.041	.218	.094
INF/KNOW	.319	.201	.242	-.026	.137	-.047	-.049
POLICY	-.057	-.003	.051	.108	-.064	-.048	-.009
PROCEDR	.048	.089	.152	.106	.069	.092	-.066
SPONSORS	.291	.064	.213	.024	.149	.094	-.083
SETTINGS	.033	.124	.243	.107	-.065	.317	-.130

CORRELATION MATRIX (CON'T)

	SOUND	TYPE1	TYPE2	TYPE3	TYPE4	TYPER	ACTFUND
MERIT	.242	.068	.212	.300	.098	-.474	.464
B/C	.591	.244	.048	.235	-.006	-.323	.176
MISCNTRD	.399	.203	.245	.067	.078	-.346	.327
NAVYOP	.433	.070	.090	.220	-.009	-.283	.290
RISK	-.335	-.152	.073	.070	.030	-.073	.223
DODRD	.106	.081	.249	-.044	.092	-.216	.241
TRANSITN	.406	.022	-.179	.045	-.034	.108	.003
SOUND	1.000	.302	-.053	.141	.074	-.201	.197
TYPE1	.302	1.000	-.092	-.101	-.023	-.184	-.119
TYPE2	-.053	-.092	1.000	-.285	-.065	-.518	-.077
TYPE3	.141	-.101	-.285	1.000	-.071	-.568	.222
TYPE4	.074	-.023	-.065	-.071	1.000	-.129	.105
TYPER	-.201	-.184	-.518	-.568	-.129	1.000	-.108
ACTFUND	.197	-.119	-.077	.222	.105	-.108	1.000
LFUND	.194	-.126	.056	.349	.134	-.327	.778
INTEGRTN	.056	-.014	.235	-.007	.117	-.208	.210
PERCENT	.018	.053	-.272	.168	-.157	.098	-.104
YRS	.147	.020	.241	.335	.080	-.516	.357
INHOUSE	-.258	-.085	.157	-.175	-.017	.061	-.052
DIFFCLTY	.271	.124	-.175	.253	-.036	-.113	.207
CONTRCT%	.054	-.078	.032	.092	.235	-.138	.258
INF/KNOW	.100	.079	.114	.141	.055	-.254	.196
POLICY	.093	-.147	-.093	.156	-.103	.020	.240
PROCEDR	.084	.074	.208	.015	.052	-.220	.096
SPONSORS	-.032	-.129	-.087	.061	.244	.003	.564
SETTINGS	.165	.210	.142	-.084	.035	-.126	.115

CORRELATION MATRIX (CON'T)

	LFUND	INTEGRTN	PERCENT	YRS	INHOUSE	DIFFCLTY	CONTRCT%
MERIT	.528	.091	-.062	.477	-.156	.280	.170
B/C	.231	.014	.008	.173	-.304	.291	.070
MISCNTRD	.396	.258	-.284	.307	-.164	.195	.169
NAVYOP	.329	-.115	.069	.291	-.054	.024	.170
RISK	.213	.298	-.301	.228	-.018	.074	.041
DODRD	.305	.334	-.350	.130	.076	.021	.218
TRANSITN	-.027	-.320	.374	-.161	-.107	.047	.094
SOUND	.194	.056	.018	.147	-.258	.271	.054
TYPE1	-.126	-.014	.053	.020	-.085	.124	-.078
TYPE2	.056	.235	-.272	.241	.157	-.175	.032
TYPE3	.349	-.007	.168	.335	-.175	.253	.092
TYPE4	.134	.117	-.157	.080	-.017	-.036	.235
TYPER	-.327	-.208	.098	-.516	.061	-.113	-.138
ACTFUND	.778	.210	-.104	.357	-.052	.207	.258
LFUND	1.000	.239	-.120	.420	-.056	.148	.267
INTEGRTN	.239	1.000	-.911	.290	.003	.087	.151
PERCENT	-.120	-.911	1.000	-.194	-.007	-.049	-.130
YRS	.420	.290	-.194	1.000	-.088	.173	-.102
INHOUSE	-.056	.003	-.007	-.088	1.000	-.857	-.086
DIFFCLTY	.148	.087	-.049	.173	-.857	1.000	.044
CONTRCT%	.267	.151	-.130	-.102	-.086	.044	1.000
INF/KNOW	.449	.209	-.138	.278	-.357	.374	.080
POLICY	.236	.033	-.089	.138	.069	-.032	-.118
PROCEDR	.047	.260	-.226	.155	.208	-.178	.149
SPONSORS	.392	.181	-.144	.046	-.127	.113	.322
SETTINGS	.183	.302	-.308	.110	-.070	.110	.094

CORRELATION MATRIX (CON'T)

	INF/KNOW	POLICY	PROCEDR	SPONSORS	SETTINGS
MERIT	.319	-.057	.048	.291	.033
B/C	.201	-.003	.089	.064	.124
MISCNTRD	.242	.051	.152	.213	.243
NAVYOP	-.026	.108	.106	.024	.107
RISK	.137	-.064	.069	.149	-.065
DODRD	-.047	-.048	.092	.094	.317
TRANSITN	-.049	-.009	-.066	-.083	-.130
SOUND	.100	.093	.084	-.032	.165
TYPE1	.079	-.147	.074	-.129	.210
TYPE2	.114	-.093	.208	-.087	.142
TYPE3	.141	.156	.015	.061	-.084
TYPE4	.055	-.103	.052	.244	.035
TYPER	-.254	.020	-.220	.003	-.126
ACTFUND	.196	.240	.096	.564	.115
LFUND	.449	.236	.047	.392	.183
INTEGRTN	.209	.033	.260	.181	.302
PERCENT	-.138	-.089	-.226	-.144	-.308
YRS	.278	.138	.155	.046	.110
INHOUSE	-.357	.069	.208	-.127	-.070
DIFFCLTY	.374	-.032	-.178	.113	.110
CONTRCT%	.080	-.118	.149	.322	.094
INF/KNOW	1.000	.086	-.053	.232	.210
POLICY	.086	1.000	.053	.022	.188
PROCEDR	-.053	.053	1.000	-.068	.099
SPONSORS	.232	.022	-.068	1.000	.125
SETTINGS	.210	.188	.099	.125	1.000

APPENDIX F

PROPOSED PROJECT INFORMATION SHEET

PROJECT INFORMATION SHEET

The information you provide here is part of the information that will used by a set of judges to rate your project. Please complete the following items as accurately and completely as possible.

Project Title_____

PI_____**code**_____**phone**_____

1. Please check the organizations funding and/or endorsing this project. For each organization checked, indicate the specific code providing funding and/or endorsing the project.

____SECNAV_____	____ONT_____
____ASN_____	____ONR_____
____DoD_____	____NAVSEA_____
____OPNAV_____	____NAVAIR_____
____SPAWAR_____	____NAVSUP_____
____NMPC_____	____NAVDAC_____
____NCPC_____	____NAVFAC_____
____NRC_____	____Other (specify)_____
____CNR_____	____Other (specify)_____
____CNET_____	____Other (specify)_____
____CNTT_____	

2. (a) What is the expected funding level ($K) for this project this year?_____
   (b) What is the expected funding level over the life of the project?_____

3. Is this project part of an integrated set of projects?_____

   If so, what percent of the total effort does it represent?

   0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. To what extent does this work support elements of your department's Work Breakdown Structure?

   0 1 2 3 4 5 6 7 8 9 10
   Not at all — Somewhat — To a great extent

5. Which element of the Work Breakdown Structure does this project most closely fit?_____

6. a) What is the *planned* start date of this project?_____
   b) What is the *planned* end date of this project?_____

7. What percent of the in-house resources (e.g., personnel, equipment, facilities) required to perform this project will be available when the project is *initiated*?

   0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

8. What percent of the total funding for this project is to be contracted?

   0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

9. Please indicate what will change as a result of this project's end-products.

   ____Information/knowledge
   ____Policy
   ____Procedures/Techniques

APPENDIX G

PROPOSED PROJECT RATING FORM

PROPOSED LAWPAS RATINGS

Project Title_____

PI_____ **code**_____ **phone**_____

Please complete the following items for the above identified project. Information detailing the project is attached for your reference. Reference to the Navy includes both Navy and Marine Corps. If you are unable give an exact response, then give your best estimate.

1. To what extent are the issues addressed by this project important to:

   a) NPRDC?

   0 1 2 3 4 5 6 7 8 9 10
   Not at all — Somewhat — To a great extent

   b) The operational Navy?

   0 1 2 3 4 5 6 7 8 9 10
   Not at all — Somewhat — To a great extent

   c) The private sector?

   0 1 2 3 4 5 6 7 8 9 10
   Not at all — Somewhat — To a great extent

2. To what extent do the issues addressed by this project correspond with **NPRDC's** formal mission?

   0 1 2 3 4 5 6 7 8 9 10
   Not at all — Somewhat — To a great extent

3. To what extent is **NPRDC** uniquely qualified to do this work?

   0 1 2 3 4 5 6 7 8 9 10
   Not at all — Somewhat — To a great extent

4. To what extent does this project build upon:

a) NPRDC research and development?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

b) other Navy research and development?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

c) other DoD research and development?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

5. To what extent does this project integrate with current:

a) NPRDC projects?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

b) other Navy R&D projects?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

c) other DoD R&D projects?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

6. To what extent does the approach for this project seem to be:

a) methodologically sound?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

b) theoretically sound?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

c) feasible?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

7. To what extent are there:

a) administrative risks (delays, cuts in funding, etc.) associated with pursuing this project?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

b) technical risks associated with pursuing this project?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

8. To what extent will the end-product(s) from this project be useful to the R&D community?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

9. To what extent will the end-product(s) from this project be useful for Navy applications?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

10. To what extent will the end-product(s) from this project reflect positively on NPRDC?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

11. What is the probability that end-products from this project could be implemented?

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

12. To what extent will this work facilitate future opportunities for funding and/or applications?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

13. Please indicate to what extent this project, compared to other NPRDC projects, is or will be <u>important</u> and <u>valuable</u> to the Navy by:

a) improving Navy effectiveness (e.g., meeting operational requirements, achieving stated goals)?

0	1	2	3	4	5	6	7	8	9	10
Value less than 90% of projects					Value equal to middle 20% of projects					Value greater than 90% of projects

b) improving Navy efficiency (e.g., improving use of resources, reducing costs)?

0	1	2	3	4	5	6	7	8	9	10
Value less than 90% of projects					Value equal to middle 20% of projects					Value greater than 90% of projects

c) expanding the technical base (e.g., developing new technology, procedures)?

0	1	2	3	4	5	6	7	8	9	10
Value less than 90% of projects					Value equal to middle 20% of projects					Value greater than 90% of projects

14. Overall, to what extent do you perceive the benefits of undertaking this project outweighing the costs?

0	1	2	3	4	5	6	7	8	9	10
Not at all					Somewhat					To a great extent

APPENDIX H

INSTRUCTIONS FOR CALCULATING PREDICTED MERIT

FOR PROPOSED PROJECTS

LABORATORY WORKLOAD PRIORITIZATION AND ACCEPTANCE SYSTEM (LAWPAS)

The following instructions describe how to use LAWPAS to predict the merit of potential projects.

1. Ask the principal investigator (PI) of the proposed project to complete the *Proposed Project Information Sheet* (Appendix F) and to provide any additional documentation describing the project, such as a project plan or technical development plan.

2. Identify three attribute raters. Provide the raters with the *Proposed Project Information Sheet* and documentation for the project. Ask the raters to review these items and to complete the *Proposed Project Rating Form* (Appendix G).

3. Combine the three attribute rater scores for each question and calculate the mean for each item in the questionnaire. This is the rating value that will be used in the next step.

4. Combine the rating values from step 3 to create the variables in the predicted merit equation. After totaling the appropriate items, calculate the mean. This is the value you will enter into the equation to calculate the project's predicted merit. The questionnaire items are combined from the *Proposed Project Rating Form* (Appendix G) as follows:

MISCNTRD *Centrality to NPRDC Mission*

Questionnaire items
1a. To what extent are the issues addressed by this project important to NPRDC?
2. To what extent do the issues addressed by this project correspond with NPRDC's formal mission?
4a. To what extent does this project build upon NPRDC research and development?
5a. To what extent does this project integrate with current NPRDC projects?
8. To what extent will the end-product(s) from this project be useful to the R&D community?
10. To what extent will the end-product(s) from this project reflect positively on NPRDC?
12. To what extent will this work facilitate future opportunities for funding and/or applications?
13c. To what extent is/will this project, compared to other NPRDC projects, be <u>important</u> and <u>valuable</u> to the Navy by expanding the technical base (developing new technology, procedures, etc)?

RISK *Project Risk*

Questionnaire items
3. To what extent is NPRDC uniquely qualified to do this work? (This item is reverse scored.)
4b. To what extent does this project build upon other Navy research and development?
5b. To what extent does this project integrate with current Navy R&D projects?

7a. To what extent are there administrative risks associated with pursuing this project?
7b. To what extent are there technical risks associated with pursuing this project?

DODRD *Connectivity with DOD R&D*

Questionnaire items
4c. To what extent does this project build upon other DoD research and development?
5c. To what extent does this project integrate with current Dod R&D projects?

TRANSITN *Likelihood of Transitioning*

Questionnaire items
6c. To what extent does the approach for this project seem to be feasible?
11. What is the probability that end-products from this project could be implemented?

Note: The following two variables did not enter into the current merit equation, but may be of interest to calculate and track.

NAVYOP *Usefulness to Operational Navy*

Questionnaire items
1b. To what extent are the issues addressed by this project important to the operational Navy?
9. To what extent will the end-product(s) from this project be useful for Navy applications?
13a. To what extent is/will this project, compared to other NPRDC projects, be important and valuable to the Navy by improving Navy effectiveness (e.g., meeting operational requirements, achieving stated goals, etc.)?
13b. To what extent is/will this project, compared to other NPRDC projects, be important and valuable to the Navy by improving Navy efficiency (e.g., improving use of resources, reducing costs, etc.)?

SOUND *Scientific validity*

Questionnaire items
6a. To what extend does the approach for this project seem to be methodologically sound?
6b. To what extend does the approach for this project seem to be theoretically sound?

5. Gather the funding information from Form 1498 for the following variables:

LFUND	Log transform of the best estimate of actual funding for FY88 (item 17d on Form 1498 or item 2a on *Proposed Project Information Sheet*).
TYPE3	If program element funding type is 6.3, value is 1, otherwise 0 (item 10a).

6. Gather the PI information from the *Proposed Project Information Sheet* for the following variables:

INHOUSE	What percent of in-house resources required are available at startup (question 7)?
POLICY	Will the end-products change policy (question 9)? If true, value is 1, otherwise 0.

7. Put the data from steps four and five into the following equation to calculate the project's predicted merit:

PMERIT = (.630 * MISCNTRD) + (.830 * LFUND) + (-.196 * DODRD)
+ (-.560 * POLICY) + (.524 * Type3) - 1.214*

**Note: The weights reported here in the equation differ from those found in the text because they are the unstandardized regression weights.*

8. If you are interested in calculating the predicted overall benefit/cost score of the project (determined from attribute raters' data), use the following equation:

PB/C = (.786 * MISCNTRD) + (.452 * TRANSITN) + (.500 * TYPE3)
+ (.007 * INHOUSE) + (-.108 * RISK) - .487*

**Note: The weights reported here in the equation differ from those found in the text because they are the unstandardized regression weights.*

9. Compare the predicted score with scores of existing projects and other proposed projects to get an indication of where this project stands in terms of predicted merit.

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